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Subject: AT&T OETC Quarterly Technical Report for Oct-Dec 1993[1]

Date: Jan 13, 1994
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Enclosed please find copies of the Quarterly R&D Status and Technical Reports for ARPA Contract MDA972-92-C-0074 covering the period of Oct 1 through Dec 31, 1993.

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Summary of AT&T Quarterly Report Oct-Dec, 93

Task A.1: VCSEL fabrication

1. Processing: Full 2" mechanical wafer processing was demonstrated in MH. Processing of two OETC wafers have been completed but device did not lase due to poor contacts results from contamination in SiN-assisted lift-off. Three more OETC wafers were being processed in MH.

W#1378 which has properly designed metal width of 20 μm for high speed operation, was diced. However, debris and residue were found during chip separation process. They have to be removed before die-bonded to Si base plate in OSA assembly. Method was being developed to remove residue on these SEL array chips.

2. Testing: W#1378 were undergone complete wafer level testing, software was fully debugged, and chip screening procedure for final wafer yield was established. All automated test equipment was moved to MH on Dec 15, 93.

3. Device High Speed Characterization at MM:

(1) For light coupled into a 1 meter long 62.5 μm graded index (GRIN) multimode (MM) fiber and with I_{th} = 4.5 mA, I_{bias} = 6 mA, and I_{mod} = +/- 3 mA, when the SEL was modulated at 500 MHz (Return to Zero, RZ), using Pseudo-Random Bit Sequence (PRBS) of 2^7 - 1, the BER was found to be < 10^{-11}. This is not true for high PRBS (> 2^{10} - 1); this is attributed to poor impedance matching of the laser. (2) With a 62 Ω resistor in parallel with the SEL, the BER is < 10^{-11} at PRBS up to 2^{23} - 1. (3) Further measurement at 700 MHz, RZ, BER ~ 10^{-14} was observed with 2^{23} - 1 PRBS for a period of 23 hour of error free transmission.

Milestone 12 (this Quarterly Report) of Task A.1 is completed.

1.2 Task A.2: Transmitter packaging

Summary: In this quarter, the fabrication of the Film Integrated Circuit (FIC) were completed. Assembly of 5 Tx modules were almost completed except for re-work of the final wire bonding of the GaAs laser array drive IC chip to the FIC.

10 mechanical and 10 good laser driver chips were received from MM (Oct 12, 93). MCM-C fabrication was completed: masks for MCM-C substrate were procured, art work was received, front to backside via were drilled, ceramic substrate was prepared. This was followed by: sawing, capacitor and lead frame attachment, etc. Five OSAs (5 low speed SEL arrays from W#1374 + 10 discrete Si PDs + 10 Si base plates + 5 heat spreaders) sent to MV, AT&T on Nov 16, 93 to be assembled with the POLYFIC and laser driver ICs + op amps. Five Tx modules were being wire bonded by an outside company that did the wire bonding for the Rx modules. However, damages to the air bridge structures on

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Subject: **Sixth Quarter Report**
on DARPA Contract MDA972-92-C0074

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The following reports on the AT&T charges as a function of the progress on each of the major tasks on the DARPA Contract MDA972-92-C0074. The charges on this Firm Fixed Price contract are based on the contract estimate. The clear portion of the bar chart shows the charges by Task for the sixth quarter, while the shaded portion shows the anticipated charges for the seventh quarter. The straight line shows single point cumulative amounts for the first, second, third, fourth, fifth and sixth quarters.

D. J. Lynes

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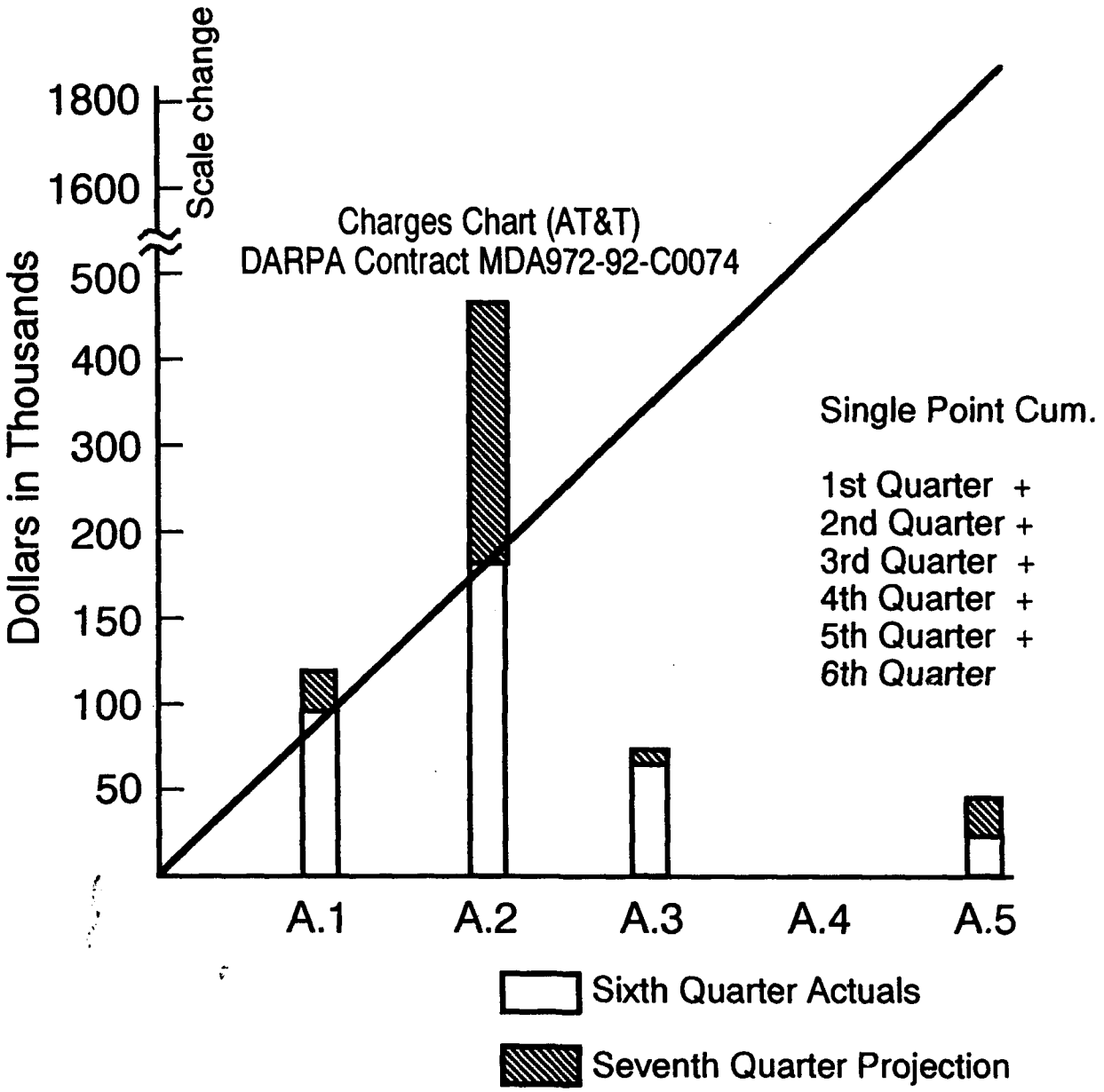
Att.
As stated



Milestones Completed

the GaAs IC driver chips were found under high resolution microscope in the final inspection. The cause was attributed to insufficient clearance in a reverse clamp position. This latter case occurred in order to avoid contacting the decoupling capacitors. Thus the wire bonding of these 5 Tx modules will be reworked. (As of 1/13/94, 3 were successfully reworked; 2 had been delivered to MM on Jan 11, 94 and 1 will be delivered later).

Except Milestones 9 and 13 (Status Report on test assembly and Deliver 8-12 Modules-Start) which are delayed due to waiting for data link test results from Martin Marietta, Milestone 10, 11, and 14 (Packaged array Ver. 2, Deliver Prototype Models, and this quarterly report) have been completed.

1.3 Task A.3: Receiver packaging

Summary: In this quarter, 4 Rx modules were delivered to MM during the period Nov 12-24, 93. Since this was the first time we exercised the full assembly cycle, some detail fabrication and assembly issues were uncovered, and resolved.

7 MSM (detector array only) chips, 7 mechanical receiver ICs, and 10 functional MSM detector array chips were received from IBM (Oct 18, 93).
7 out of 10 heat spreader have been received from TI. TI found remaining heat spreaders more porous, and stop shipping them. TI also ran out of material therefore the remaining 3, will have to wait for new supply of material. Since Rx module is expected to dissipate less heat than the Tx module, we decided to save the Silvar heat spreader for the Tx modules, and use the Al heat spreader for some of the Rx modules.

10 OSAs were shipped to MV, AT&T since Oct 10, 93 to be assembled with the MCM-C substrates.

Problem was found in solder paste screening process for the attachment of the decoupling capacitors. This resulted in multiple screening steps, leading to cracking of the ceramic substrates. 1 substrate was readied for final assembly with the OSA. Due to some quality concern, and since the next batch of substrate would soon be available in a week (second run), we decided to terminate the complete process.

The following table shows the completion of Rx delivery from the second run in 1993.

IBM # Rcd (10/18)	Heat Spreader	FAB #	Date To MV	MV ID	Date To MM	Ultimate Destination	Comment
31R"B"	-	25	-	1	-	-	Not assembled
23R"A"	Silvar	51	10/20	2	/	Chet	damaged in wire bonding
28L"B"	Silvar	38	10/20	3	11/18	MM	3 Mirrors 22,23,24; scraped in cleaning
30R"A"	Silvar	18	10/20	4	11/12	MM	

IBM # Rcd (10/18)	Heat Spreader	FAB #	Date To MV	MV ID	Date To MM	Ultimate Destination	Comment
32R"B"	Al	44	11/09	5	/	Dirk	3 Cdec damaged; dicing problem
24L"C"	Al	40	11/09	6	11/24	MM	
23L"A"	Al	27	11/10	7	11/24	MM	
24R"A"	Al	45	11/09	8	/	Chet	2nd conductor damaged; Being repaired

Milestones 5 and 7 (Deliver Mechanical Models Ver. 1 and Prototype Models) have been completed. Milestone 6 (Package Production - Start) is delayed due to waiting for module test results from MM.

1.4 Task A.4: Fiber connector

Summary: Second order issues that were related to plug and play of MACII cable to the Tx or Rx modules were addressed. We also provided to MM and IBM MACII-fanout cable jumper for future testing purpose.

8 interface cables of length 0.5 meter each that allow one to connect Tx and Rx directly without panel connectors, were received (6 on Oct 12, 93 and 2 on Nov 19, 93).
1 MacII cable with 2 MacII connectors was shipped to IBM at IBM's request (Oct 22, 93). 2 fanout ST connectors could be made on one end of the cable if the cable was cut at the center.

Plugging the present MacII-32 cable to a Rx requires some looking into the cavity of the module. Also the force of securing the two external screws is arbitrary. This may cause damage of the fiber array polished facet. A design concept that involves an additional spring is being studied to solve the latter problem.

1.5 Task A.5: Project management

This quarter involves final acquisition of all piece parts from IBM, MM, and foundries. Priorities and plans were set to make good use of available parts first for the Rx modules, then for the Tx modules.

Issues and details of final packaging have been settled through video and teleconferencing between Indian Hill (heat spreader design), Merrimack Valley (compatibility between MCM-C, heat spreader, OSA), Whippany (MacII connector hardware), and Murray Hill (SEL array and FAB). High speed board fabrication responsibility was discussed, and relegated to MM.

OETC 3 rd User Group meeting was held on Nov 19, 93. AT&T summarized and presented results on high speed characterization of SEL, discuss uniformity and high temperature data in operation parameters across a full 2" wafer from automated wafer test set, showed measurements of laser to multimode fiber coupling efficiency, optical cross-talks at transmitting and receiving ends, simple optical continuity of the optical link via plug and play laser array-MACII connector -MSM detector array, and MACII connector loss histogram data, and finally complete Rx module hardware, with Tx in the making. Companies (Storage Tek, Boeing, Unisys, etc) were very interested in specifics for the OETC project: link specifications, reliability, and cost.

2. Anticipated Activities for Jan-March 94

2.1 Task A.1: VCSEL fabrication and testing

We will continue to grow wafers in STC, and process these OETC-spec wafers in MH. One wafer shows good quality: low oxygen contamination. Broad area laser will be tested by 1/18/94. Automated testing facilities in MH will be up by 1/17/94. 2" wafer processing capability in MH will be proven-in in 1st week of Feb. Functional SEL arrays will be available by the end of Feb, 94.

2.2 Task A.2: Transmitter packaging

The Tx modules that were delivered to MM contain the 100 μm metal trace. Hence, the simulated data rate is ~ 200 Mbps. We plan to package some (~ 3) high speed SEL arrays (with 20 μm metal trace for impedance matching) with the MCM-C so that MM can test the Tx modules at full speed of 500 Mbps.

Once high speed test results are available (Feb-March, 94) from MM, a package review among the OETC members will be held (March, 94) to understand all package design implications from these high speed measurements. If a re-design of the package and/or device is found necessary, a second package iteration to fulfill the contract will start after this progress review.

Since the detail layouts of the MCM-C for both Tx and Rx module are available, we also intend to simulate the electrical performances of the MCM-C in more detail.

With the help of past packaging experiences, time frame (8 weeks) and cost of the next full design cycle will be firmed up. A delivery of 3 Tx modules on May 15 will finalize the phase I OETC design. This will be followed by final delivery of the remaining 6 Tx modules in Sept-Nov time frame.

2.3 Task A.3: Receiver packaging

Direction of work in 94 will be determined by the outcome of the Rx module testing provided by MM.